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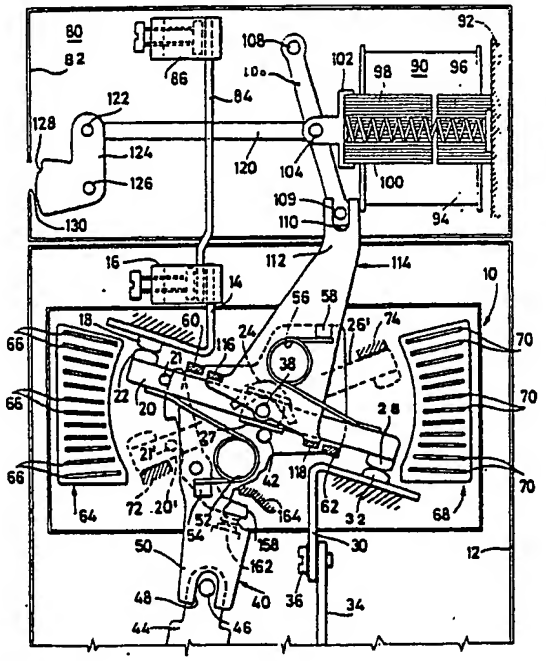
(54) Improved contact arrangement for a current limiting circuit breaker adapted to be actuated both manually and by an actuating electromagnet.

(57) Current limiting contact arrangement, of the free repulsion type, consisting of a modular unit (10) to be housed in an usually insulating box (12), provided with two fixed contact arms (14, 30) and at least two movable contact arms (20, 26) which can be actuated both manually by means of a rod (44) coupled to driving means, and electrically by means of an electromagnetic actuator (80) driving said movable contact arms (20, 26) through a lever (106) and a rotating bracket member (114) so as to cause contact pairs (18, 22; 28, 32) to be held in an open condition as an electromagnet (90) of said actuator (80) is de-energized.

Fig.1



IMPROVED CONTACT ARRANGEMENT FOR A CURRENT LIMITING CIRCUIT BREAKER ADAPTED TO BE ACTUATED BOTH MANUALLY AND BY AN ACTUATING ELECTROMAGNET

The present invention is an improvement of the invention disclosed and claimed in EP-A-. In the mentioned publication there are disclosed several contact arrangements of the free repulsions type, arranged, as modular units, within single-pole boxes and adapted to be driven both manually and by electromagnetic actuators, said arrangements consisting of two fixed contact arms, on which abut two movable contact arms connected to one another by means of a flexible conductor braid and adapted to be turned in mutually opposite directions by means of two supporting members operated by two driving rods coupled to a push rod which can be operated by separate driving means.

The above disclosed contact arrangements operate in a satisfactory manner: however, because of the rotation in mutually opposite directions of the movable contact arms, entrained by said supporting member, the flewible conductor braid connecting said arms is greatly stressed, as it is greatly bent, thereby decreasing it's operating life.

Moreover, since each movable contact arm is provided with a respective supporting member, the mechanism driving said arms is of very complex construction with a consequent high cost.

Another drawback is that since two supporting members are used for two movable contact arms, a driving mechanism with an electromagnetic actuator affecting a single movable arm must be used. In fact a driving mechanism able of simultaneously operating both said movable arms would be very complex and expensive.

Accordingly, a main object of the present invention is to provide a contact arrangement which is more simple than that of the mentioned publication while providing like electric performance.

Another object is to provide an improved contact arrangement, adapted to be actuated both manually and by an electromagnetic actuator in which the two actuations affect both the movable contact arms.

Another object is to provide an improved contact arrangement in which the manual actuation is performed by bringing nearer and moving away contacts, with an associated displacement of said contacts able of causing said contacts to rub one against the other in order to remove possible oxide films thereby providing a small contact resistance or removing possible microweldings.

Still another object is to provide a contact arrangement all of the component elements of which can be assembled by a single direction displacement and in which the contact elements can be coupled both to the manual driving mechanism and to the electromagnetic actuator by means of simple translation movements.

According to one aspect of the present invention, the above mentioned objects, as well as yet other objects which will become more apparent hereinafter, are achieved by an improved contact arrangement for a current limiting breaker, of the free repulsion type, consisting of a modular unit to be housed in a usually insulating box or compartment, comprising two fixed contact arms provided with contacts, two movable contact arms provided with contacts and adapted to be driven both manually, by a rod coupled to driving means, and electrically by an electromagnetic actuator driving said movable contact arms, characterized in that said movable contact arms are pivoted on a single pivot pin arranged at the ends of said movable arms opposite to the ends thereof supporting the contacts, so as to cause said movable arms to rotate in the same direction, said single pivot pin being supported by a single rotatable member which can be driven by said rod for manual actuations, said electromagnetic actuator controlling a rotating bracket member which causes said movable contact arms to be brought to their open condition as an electromagnet of said electromagnetic actuator is de-energized.

More specifically said movable contact arms are electrically coupled to one another by means of a flexible braided conductor an one of said arms is provided with a detent member for preventing said movable contact arms from being disaligned beyond a given limit.

In particular, at least one of said movable contact arms is provided with a pin or peg adapted to be engaged by a latching mechanism which can be disengaged by rotating said rotating member.

The latching or engaging mechanism consists of a lever including a fulcrum fixed to said rotating element, having a first end provided with a sliding surface and a latching tooth, and a second end or tail abutting against a spring in turn abutting against a ridge of said rotating element and the stroke of which is restrained by a shaped projection rigid with the supporting structure of said modular unit so as to latch said at least one of said movable contact arms after an opening due to an electrodynamic repulsion caused by a short circuit current so as to prevent said at least one arm by causing said second end or tail to engage against said shaped projection as the rotating member is brought to its open position by external tripping members or as the breaker is manually reset.

In further details, said contact arrangement, in which the movable contact arms are pivoted on a pin fixed to said rotating element is characterized in that said pin does not coincide with a rotation center thereabout the rotating element driven by said rod turns as the breaker in manually operated, in order to be displaced on a circle arc to provide a tangential or rubbing movement of the movable contacts on the fixed contacts.

The pivot pin of said movable contact arms is eccentrical with respect to the rotation center of the rotating element and moreover it is offset from the contact normal symmetry axis passing through the rotation center of said contacts coinciding with said pin, so as to cause said pin to be displaced as the breaker is manually operated, on a circle arc which is not tangent to a longitudinal axis of said movable contact arms passing through their rotation center in order to provide, in addition to the mentioned rubbing movement, also a rotating movement of said movable contacts on said fixed contacts, in order to lessen the contact bounce and subject the contacts to a twisting moment adapted to remove possible weldment regions formed between said contacts.

The rotating element is provided with a lug including an open slot engaged by a pin supported by said rod coupled to manual operation or driving means and with two first projections restraining two springs adapted to push said movable contact arms to their closure position.

The rotating element is moreover provided with two projections adapted to entrain said movable contact arms to their openin position.

Said rotating bracket member is preferably engaged on the single pin of the two movable contact arms and is provided with projections adapted to be engaged with the movable contact arms to displace them to the opening position as the electromagnet of said electromagnetic actuator is de-energized.

Said rotating bracket member is further provided with a lug to engage, by an open slot formed therethrough, in a pin supported by a lever which is driven or controlled by said electromagnet of said electromagnetic actuator.

Said electromagnet further controls, through a tie rod, a cranck lever provided with an indicating flag facing a window of a box holding said electromagnetic actuator.

Further characteristics and advantages of the present invention will become more apparent hereinafter from the following detailed description of a preferred embodiment thereof, with reference to the accompanying drawings, where:

figure 1 shows the contact arrangement according to the present invention including a driving electromagnet;

figure 2 shows a detail of a latching mechanism of a movable contact arm which operates as hereinbelow disclosed;

figure 3 schematically shows the vectors of the forces originally applied to the arms of the contacts during the manual opening operation, which are very useful since they provide a rubbing action on the contacts and are able of detaching them if welded by possible overcurrents and correspondingly shows those same forces as reversed during the manual closing operation, which reversed forces cause the cooperating conatct members to mutually rub and roll.

With reference to figure 1 which shows a modular unit 10 holding a con tact arrangement according to the present invention, housed in a breaker casing 12, said contact arrangement consists or a first fixed contact arm 14 which bears, at a first end thereof, a clamp 16 and, at the second end thereof, a contact 18; of a first movable contact arm 20, bearing a contact 22; of a flexible braided conductor 24 coupled to the movable arm 20; a second movable contact arm 26, also coupled to the flexible conductor 24 and bearing a contact 28; a second fixed contact 30 bearing a contact 32; and an output coupling conductor 34 coupled by a screw 36 to said fixed contact arm 30.

The two movable contact arms 20 and 26 are able of rotating about a pivot pin 38 affixed to a supporting element or member 40 which is in turn able of rotating about a pin 42 rigid with the unit 10 supporting structure. Moreover the contact arm 26 is provided with a projection or fin 27 adapted to prevent the two movable arms from being disaligned beyond a given limit. It should be apparent that this projection or fin 27 can also be coupled to the other movable contact arm 20.

Said supporting element 40 is pushed to the position shown in figure 1 by means of a rod 44 which operates through a pin 46 coupled to said rod 44 within a slot 48 formed through a lug 50 of said supporting rotating element 40. Said rod 44 is obviously coupled to the breaker operating or actuating means (not shown).

The movable contact arm 20 is held in the position of figure 1 by means of a spring 52 operating between a projection 54, also provided on the supporting element 40, and that same movable arm 20. Likewise, the movable contact arm 26 is held in the same position of figure 1 by means of a spring 56 operating between a projection 58, also provided on the supporting element 40, and said movable arm 26.

Said rotating element 40 is also provided with two projections 60 and 62 which, as said supporting rotating element 40 is counterclockwise rotated, will entrain to the open position the movable con-

tact arms 20 and 26. Two projections 72 and 74 rigid with the unit 10 supporting structure operate as detent members for the respective movable contact arms 20 and 26 as they are brought by electrodynamic repulsion to the positions 20′ and 26′.

The assembly consisting of the fixed contact arm 14 and movable contact arm 20 is arranged in front of an arc chute 64 provided with quenching plates 66. The assembly consisting of the fixed contact arm 30 and movable contact arm 26 is arranged in front of an arc chute 68 provided with quenching plates 70.

The modular unit 10 can also comprise driving and unlatching mechanisms so as to form a single pole breaker, or several modular units 10 can be assembled in an insulating box or casing 12 also holding driving and unlatching mechanisms so as to form a multipole breaker.

Moreover, at least one of the movable contact arms, for example the arm 20, can be provided with a latching mechanism consisting of a lever 150 rotatable about the fulcrum 152 having a first end provided with a sliding surface 154 and a latching tooth 156 and a second end, lug or tail 158 abutting against a spring 160 which in turn abuts against a projection 162 supported by said rotating element 40 and the stroke of which is restrained by a shaped step or ridge 164 rigid with said unit 10 supporting structure. Said latching mechanism operates so as to prevent the movable contact 22 from reclosing against the fixed contact because of a bouncing of the movable contact arm 20 against its detent projection 72. The unlatching mechanism operates as follows: as because of a short current, the movable contact arm 20 is moved away, by electrodynamic repulsion, from the fixed contact arm 14, by counterclockwise rotating about its pivot pin 38, a peg or pin 21 arranged on said arm 20 slides on the surface 154 of the lever 150 so as to pass beyond the latching tooth, thereby the lever 150 will rotate as biased by its spring 160 and will be held in abutment against the pin 21. If, because of a bounce against the projection 72 or a decreasing of the short circuit current, the movable contact arm 20, as urged by its spring 52, would tend to return to its closure position, then it would be restrained by the engagement of the pin 21 and tooth 156, as it is clearly shown by its position 21″ of figure 2. The movable contact arm 20 would be accordingly stopped at the position 20″ shown in said figure.

Then, as the tripping members operate, the supporting element 40 will be brought to the open position by means of a clockwise rotation. With this rotation, the lug or tail 158 of the latching member will rub on the suitably shaped upturned portion or projection 164, thereby said latching member will rotate so as to disengage the pin 21 of the movable contact arm 20 which will be able of abutting against its natural detent 60.

In this connection it should be apparent that said latching mechanism can be either also or alternatively provided to the movable contact arm 26. An exemplary electromagnetic actuator 80 is shown inside an insulating box or casing 82, being provided with an extension conductor or wire 84 for the fixed contact arm 14 possibly coupled to a clamp 86. Said box or casing 82 is coupled to an assembly of modular units 10 both by means of the metal extention 84 and by means of mechanical coupling means (not shown). Said casing 82 also contains an actuating electromagnet 90 which is affixed to a base 92 in turn structurally coupled to the casing 82 and comprising an energizing winding 94, on a fixed core 96, a movable armature 98 and a return spring 100 so arranged as to operate by compression between the base 92 and a bracket member 102 affixed to said movable armature 98. Throught the bracket 102 a pin 104 extends which entrains a lever 106 pivoted at one end thereof about a pin 108 affixed to said insulating casing 82. The other end of said lever 106 supports a second pin 109 engaging in a slot 110 of a lug 112 pertainting to a bracket member 114 able of rotating about the pivot pin 38 so as to push the movable contact arms 20 and 26 by means of entraining or driving projections 116 and 118 respectively.

Said pin 104 also entrains or drives a first end of a driving rod 120 having the other end thereof traversed by a pin 122 engaging one end of a first arm of a cranck lever 124 pivoted on a pin 126 affixed to the insulating casing 82.

The other arm of said lever 124 supports an indicating flag 128 facing a window 130 of the casing 82 in order to show the energized condition of said electromagnet 90 and accordingly the opening or closing condition of the contact arrangement.

As is clearly shown in figure 1, the electromagnetic actuator 80 can be added to or removed from the modular units 10 without practically obstructing their operation.

Said electromagnetic acuator 80 will open the contact pairs 18,22 and 28, 32 as the breaker operating or driving rod 44 is in its closure position. (as shown in figure 1), the electromagnet 90 is deenergized, thereby the spring 100 will move the movable armature 98 away from the fixed core 96 and then, through the bracket 102, the lever 106 and the lug 112, the bracket rotating member 114 will be counter clockwise turned, said bracket rotating member 114 entraining to opening the movable contact arms 20 and 26 respectively.

As shown in figure 1, the rotation center 42 of the rotating supporting element 40 does not co-

incide with the pivot pin 38 on which there are pivoted the movable contact arms 20 and 26 and moreover said center is also offset from the normal symmetry axis passing through the rotation center of said arms, thereby said pivot pin 38 will perform, with respect to said rotation center 42, a movement which will have on the movable contact arms 20 and 26 and on the contacts 22 and 28 associated therewith the effects which are shown in figure 3 and which will be disclosed in a detailed way hereinafter.

With reference to figure 3, it should be apparent that the assembly consisting of the rotating supporting element 40 and fixed and movable contact arms 14, 30 and 20, 26 respectively can be represented by the diagram shown herein, in which said rotating element 40 is diagramatically illustrated as consisting of the two arms R_1 and R_2, while the contact arms are represented schematically by straight line segments having the same reference numbers as the corresponding contact arms, in this figure there being also shown the points representing the respective rotation pins or centers 38, 42 and 46.

As a force F_1 is applied to the pin 46 arranged at one end of the arm R_1, this force, owing to the pin 42 operating as a fulcrum, will be transformed into a force F_2 applied to the pivot pin 38, said force F_2 having a direction tangent to a circle C centered on the fulcrum 42 and passing throhgh the pivot pin 38.

Since the lines representing the two movable contact arms 20 and 26 does not coincide with the direction of said force F_2, this force can be thought as consisting of the vectorial sum of a component F_{2T} tangent to said line of the movable contact arms 20 and 26 and a component F_{2N} perpendicular to the mentioned line.

The component F_{2T} will transmit to the movable contact arms 20 and 26 a stress parallel to said arms, which will cause the fixed contacts 18 and 32 and movable contacts 22 and 28 to mutually rub against one another, while the normal or perpendicular component F_{2N}, which is applied to the pivot pin 38, which is a hinge pin for hinge coupling the two movable contact arms 20 and 26, will urge toward the pin 42 the hinged ends of the movable contact arms which will tend to rotate their movable contacts, respectively 22 and 28, above the corresponding fixed contacts 18 and 32. Just this rotation operation on the movable contacts 22 and 28 above the fixed contacts 18 and 22 will substantially contribute to the breaking of weldment zones susceptible to be produced both as the contacts are closed and as overcurrents occur, such as short circuit currents, of a sufficiently high intensity to overheat the contacts but not sufficient to repel the contacts from one another.

On the contrary, during the closure operation, F_2, F_{2T} and F_{2N} will become F'_2, F'_{2T} and F'_{2N} which, by generating rubbing reversed with respect to the opening rubbigs, will surface clean the contacts and lessen their bounces.

If the breaker is used without the electromagnetic actuator 80, then the contact arms will be held in their closing condition as far as the rotating supporting element 40 is held in its position of figure 1 and the in tensity of the current passing through said contacts and the arms thereof is within the rated values.

If a short condition occurs, then the current intensity would be raised to such a value as to cause an electrodynamic repulsion between the respective contact arm pairs 14, 20 and 30, 26, thereby the movable contact arms 20 and 26 will be compelled to reach their opening positions 20' and 26' by overcoming the urging of their respective springs 52 and 54, as far as the short circuit current lasts.

Under the urging of the spring 32, the contact arm 20 will be then brought to the latching position defined by its pin 21 abutting against the tooth 156 of the latching mechanism, clearly shown in figure 2, said latching being released as the breaker tripping members operate which, by causing the supporting element to move to the opening position, will engage the lug or tailpiece 158 of the latching element against the shaped projection 164 which will rotate clockwise the lever 150 thereby disengaging the tooth 156 from the pin 21 and also disengaging the movable contact arm 20.

As previously discussed, the latching operation is necessary in order to prevent the contact from closing by bouncing under the effect of the great electrodynamic forces, before its opening under the control of the associated overcurrent tripping or releasing members.

If, on the contrary, the breaker is used in assiciation with the electromagnetic actuator 80, then it is not sure that, by bringding the rotating element 40 to the position shown in figure 1, the movable contact arms 20 and 26 are brought to their closing position; because it depends from the fact that the rotaing bracket member 114 must be arranged at the position shown in figure 1, which position can be obtained exclusively as the electromagnet 90 of the electromagnetic actuator is energized, that is with its armature 98 abutting against its fixed core 96 since, if the electromagnet 90 were de-energized, then the armature 98 would be moved away from its fixed core 96, under the bias of the return spring 100, thereby causing the rotating bracket member 114 to oppose by its projections 116, 118, through the bracket 102, pin 104, lever 106 with its first end 109 and lug 112, to the closing displacement of the movable contact

arms which, by overcoming the forces of their springs 52 and 56, would be brought to the opening position.

Thus, the contact of the modular unit 10 can be closed only if the manual driving rod 44 is in its closure position and the electromagnet 90 of the electromagnetic actuator 80 is energized.

Likewise, as the breaker is closed and the supporting element 40 is in the position shown in figure 1, the movable contact arms 20 and 26 can be brought to the closing position depending on whether electromagnet 90 is de-energized or energized. In this case the apparatus will operate as an actuating apparatus driven by an electromagnet.

While the invention as been disclosed and illustrated with reference to a preferred embodiment thereof it should be apparent that the disclosed embodiment is susceptible to several modifications and variations all of which will come within the spirit and scope of the appended claims

Claims

1- An improved contact arrangement for a current limiting circuit breaker, of the free repulsion type, consisting of a modular unit to be housed in a usually insulating box or compartment (12), comprising two fixed contact arms (14, 30) provided with contacts (18,32), two movable contact arms (20,26) provided with contacts (22, 28) and adapted to be driven both manually by a rod (44) coupled to driving means and electrically by an electromagnetic acuator (80) driving said movable contact arms (20, 26) characterized in that said movable contact arms (20, 26) are pivoted on a single pivot pin (38) arranged at the ends thereof supporting the contacts (22, 28), so as to cause said movable arms (20, 26) to rotate in the same direction, said single pivot pin being supported by a single rotatable member (40) which can be driven by said rod (44) for manual actuation, said electromagnetic actuator (80) controlling a rotating bracket member (114) which causes said movable contact arms (20, 26) to be brought to their open position as an electromagnet (90) of said electromagnetic actuator (80) is de-energized.

2- A contact arrangement, according to claim 1, characterized in that said movable contact arms (20, 26) are electrically coupled to one another by means of a flexible braided conductor (24) and one of said arms is provided with a detent member (27) for preventing said movable contact arms (20, 26) from being disaligned beyond a given limit.

3- A contact arrangement according to claim 2, characterized in that at least one of said movable arms (20, 26) is provided with a pin or peg (21) adapted to be engaged by a latching mechanism which can be disengaged by rotating said rotatable member (40).

4- A contact arrangement according to claim 3, characterized in that said latching mechanism consists of a lever (150) including a fulcrum (152) fixed to said rotatable member (40), having a first end provided with a sliding surface (154) and a latching tooth (156), and a second end or tail (158) abutting against a spring (160) in turn abutting against a ridge (162) of said rotatable member (40) and the stroke of which is restrained by a shaped projection (164) rigid with the supporting structure of said modular unit so as to latch said at least one of said movable contact arms after an opening due to an electrodynamic repulsion caused by a short circuit current so as to prevent said at least one arm from being suddenly closed against one of its detent members (72, 74) and then to disegage said at least one arm by causing said second end or tail (158) to engage against said shaped projection (164) as said rotatable member (40) is brought to its open position by external tripping members or as the breaker is manually reset.

5- A contact arrangement according to claims 1 to 4, wherein the movable contact arms (20, 26) are pivoted on a pivot pin (38) fixed to said rotatable member (40), characterized in that said pivot pin (38) does not coincide with a rotation center (42), about which said rotatable member (40), driven by said rod (44), turns, as the breaker is manually operated in order to be displaced on a circle arc to provide a tangential or rubbing movement of the movable contacts (22, 28) on the fixed contacts (18, 32).

6- A contact arrangement, according to claim 5, characterized in that said pivot pin (38), about which said movable contact arms (20, 26) turn, is eccentrical with respect to said rotation center (42) of said rotatable member (40) and moreover said pivot pin is offset from the contact normal symmetry axis passing through the rotation center of said contacts coinciding with said pivot pin (38), so as to cause said pivot pin (38) to be displaced, as the breaker in manually operated, on a circle arc which in not tangent to a longitudinal axis of said movable contact arms (20, 26) passing through their rotation center in order to provide, in addition to said rubbing movement, also a rotating movement of said movable contacts (22, 28) on said fixed contacts (18, 32), in order to lessen the contact bounce and subject the contacts to a twisting moment adapted to remove possible weldment regions formed between said contacts.

7- A contact arrangement, according to claim 1, characterized in that said rotatable member (40) is provided with a lug (50) including an open slot (48) engaged by a pin (46) supported by said rod

(44) coupled to manual driving means and with two first prejections (54, 58) restrainig two springs (52, 56) adapted to push said movable contact arms (20, 26) to their closure position.

8- A contact arrangement, according to claim 7, characterized in that said rotatable member (40) is provided with two projections (60, 62) adapted to displace said movable contact arms (20, 26) to their opening position.

9- A contact arrangement according to claim 7, characterized in that said rotating bracket member (114) is pivoted on the single pivot pin (30) of the two movable contact arms (20, 26) and is provided with projections (116, 118) adapted to be engaged with the movable contact arms (20, 26) to displace them to the opening position as the electromagnet (90) of said electromagnetic actuator (80) is de-energized.

10- A contact arrangement according ro claim 9, characterized in that said rotating bracket member (114) is further provided with a lug (112) to engage, by an open slot (110) formed therethrough, a pin (109) supported by a lever (106) which is driven by said electromagnet (90) of said electromagnect actuator (80).

11- A contact arrangement according to claim 10, characterized in that said electromagnet (90) further controls, through a tie rod (120), a cranck lever (126) provided with an indicating flag (128) facing a window (130) of a box (82) holding said electromagnetic actuator (80).

Fig.1

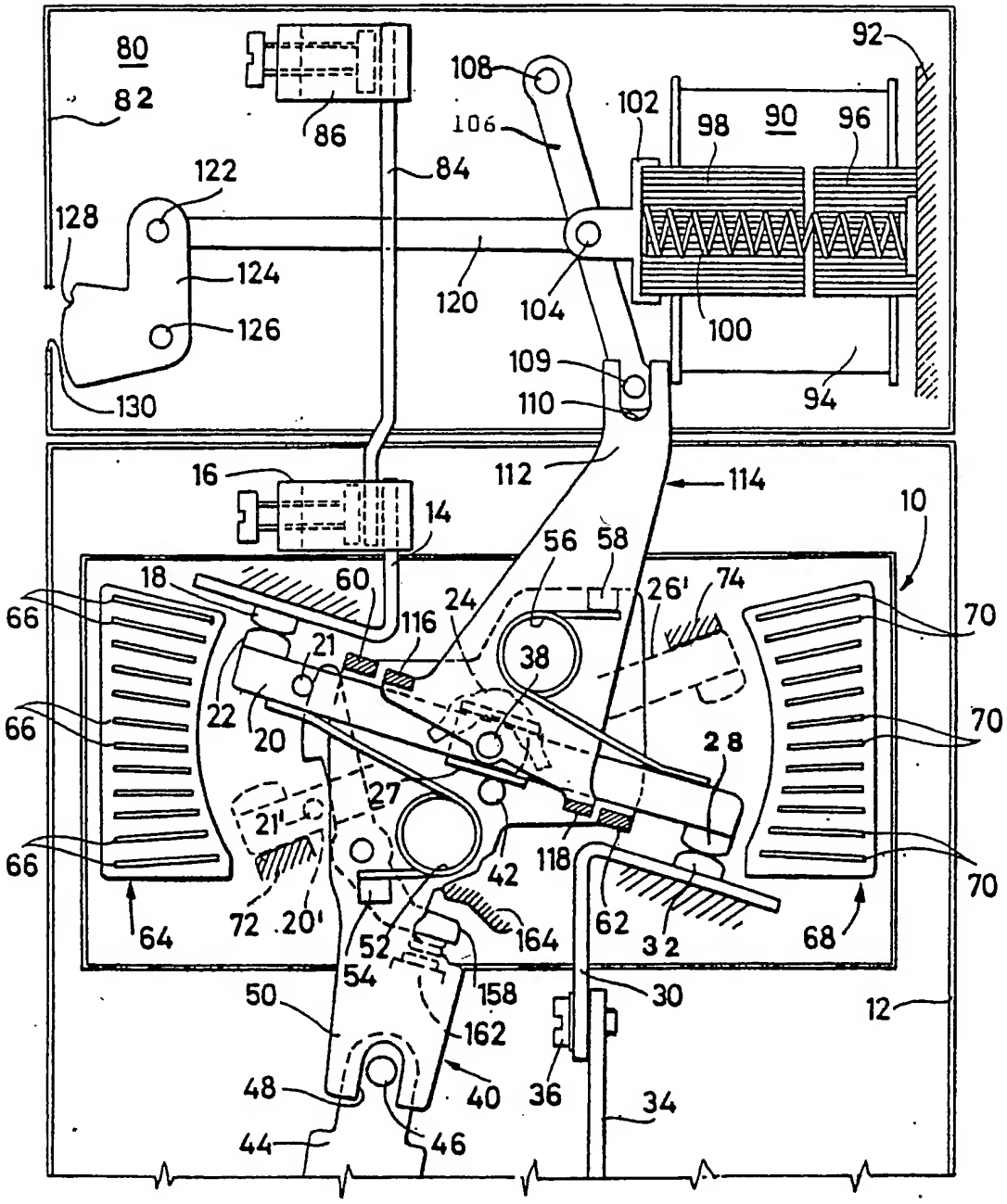

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Fig.2

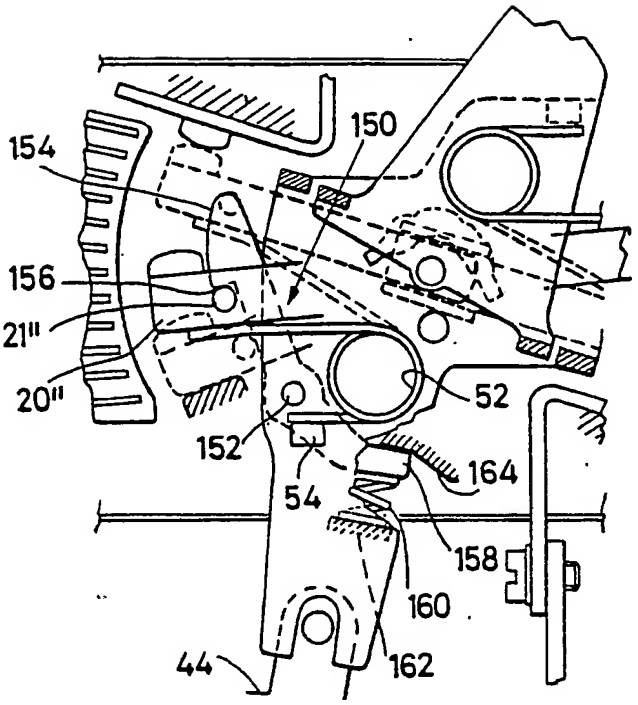
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Fig.3

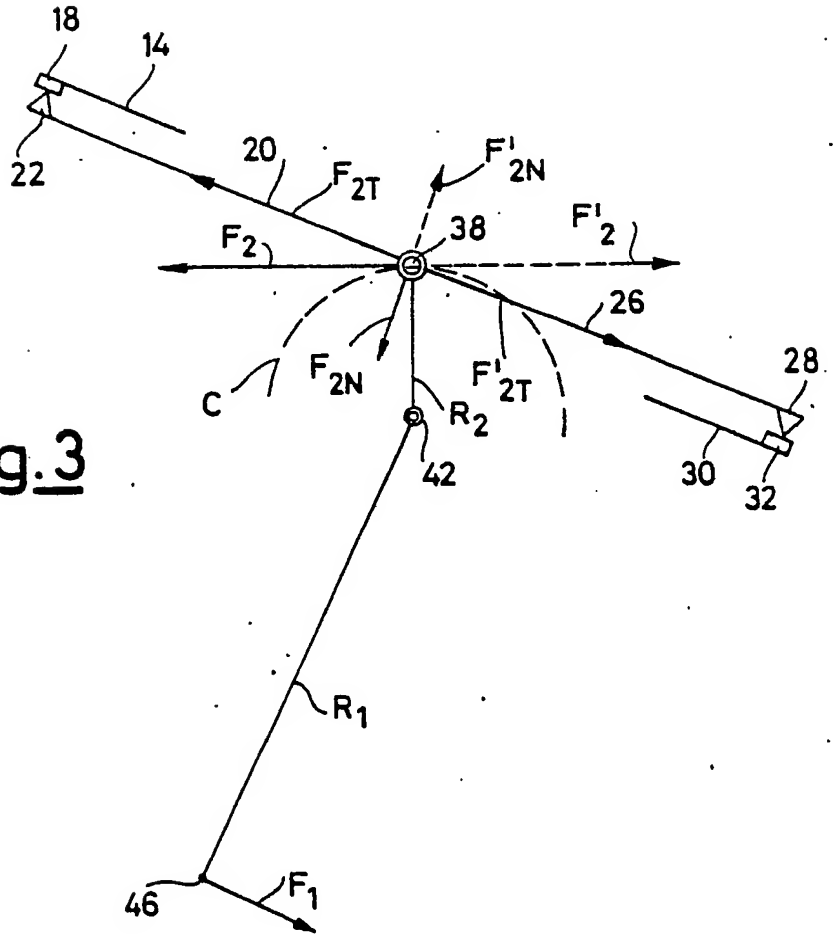
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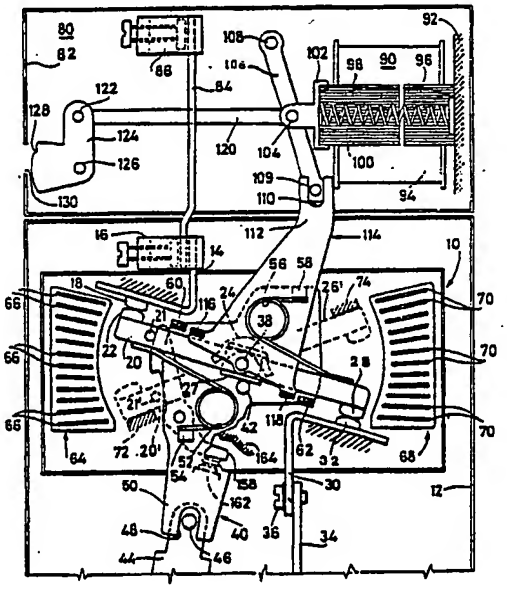
Fig.1



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EUROPEAN SEARCH REPORT

Application Number

EP 88 11 5601

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	EP-A-0 237 607 (SQUARE D. STARKSTROM GMBH) * column 5, lines 42-46; column 6, lines 47-55; figures 5-8 *	1	H 01 H 77/10 H 01 H 71/68 H 01 H 73/04
Y	FR-A-2 503 929 (I.M. KRUGLYANSKY et al.) * page 1, lines 19-27; page 5, lines 8-12; figures 1,2 *	1	
A	EP-A-0 059 475 (MITSUBISHI DENKI KABUSHIKI KAISHA) * abstract; figure 3 *	1	
A	FR-A-2 373 143 (LA TELEMECANIQUE ELECTRIQUE) * page 3, lines 21,22; figures 1,3 *	2	
A	CH-A- 227 928 (LANDIS & GYR AG) * page 2, lines 23-30; figure *	11	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 H 71/00
H 01 H 73/00
H 01 H 77/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	14-03-1990	DIOU J.M.

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